Upgrades to the R-Matrix Code SAMMY

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The analysis code SAMMY is widely used for parameterization and understanding of neutron- and charged-particle-induced cross section data in the resolved and unresolved resonance regions. This paper will report on advances made in the development of this code. An overview of the main features of SAMMY will be presented, with emphasis on options recently added to the code. These features can be divided into four categories: (1) theoretical cross sections, (2) experimental effects, (3) fitting procedure, and (4) input/output and other pre- or post-processing functions.

(1) In the resolved-resonance region (RRR), calculation of theoretical cross sections is generally performed using R-Matrix theory in the Reich-Moore approximation. In the unresolved-resonance region (URR), SAMMY uses Hauser-Feshbach theory with width fluctuations, using Froehner's FITACS code as basis.

R-Matrix theory is inherently limited to nuclear reactions involving a compound nucleus. When there is a direct component to the capture cross section, SAMMY now permits this to be added as a user-supplied numerical function of energy.

(2) In the RRR, experimental conditions cause the measured quantity to be quite different from the theoretical cross sections, and these conditions must be simulated in the analysis code. SAMMY includes a wide variety of options for this purpose; among the recent additions is an option to use crystal-lattice Doppler broadening for situations where the free-gas model is not adequate.

(3) Improvements to the fitting procedure used in SAMMY and other analysis codes, in particular with regard to the proper treatment of data covariance information, will be reported. Enhancements in SAMMY options for use of implicit data covariance matrices will be briefly described here, and the entire topic explored more fully in separate paper.

(4) As more options are created for SAMMY, the input has become more complicated. A streamlined version of input (including the particle-pair information separately from the channel quantum numbers) is now available. An auxiliary code SAMQUA, coauthored by colleagues from the French Atomic Energy Commission at Cadarache, can be used for assistance in preparing input for SAMMY.

Two new formats, approved by the Cross Section Evaluation Working Group during the 2003 meeting, now make it possible to translate any SAMMY evaluation into the Evaluated Nuclear Data Files. The "Compact Covariance Matrix" format can be used for storing resonance-parameter covariance information in an approximate fashion for those cases where the size of the matrix prohibits storage of the complete matrix. The "R-Matrix Limited" format can be used to report R-Matrix resonance parameter values in the case where there are several entrance channels, more than two exit channels, one or more threshold reactions, and/or charged-particle channels. The code SAMRML can be used to read resonances parameters from this format and calculate cross sections and sensitivity matrices (partial derivatives).

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